

Planar Silicon Metamaterial Lenslet Arrays for Spaceborne Millimeter-wavelength Imaging

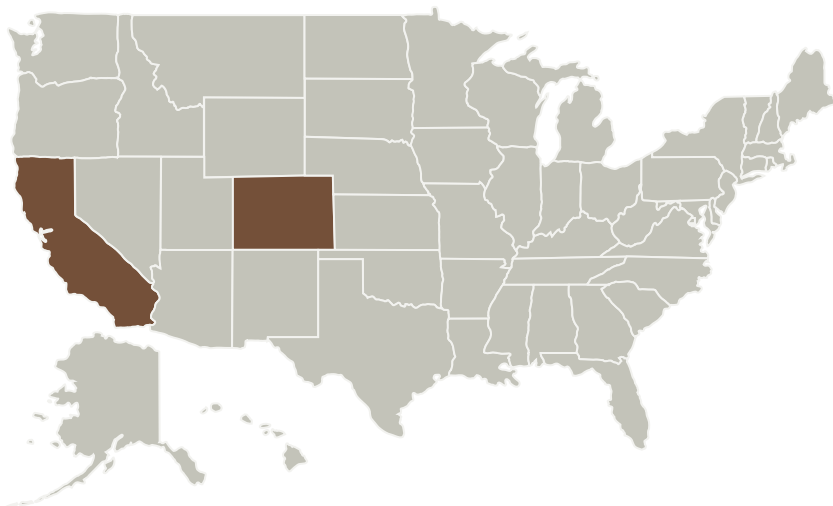
Completed Technology Project (2017 - 2019)



Project Introduction

Large imaging arrays of detectors at millimeter and submillimeter wavelengths have spaceborne applications that include measurements of the faint polarization signal in the Cosmic Microwave Background (CMB), and submillimeter astrophysics. Precision spaceborne measurements of the faint CMB polarization signal have the potential to probe physics at GUT energy scales, when the universe was thought to have undergone a rapid period of exponential expansion called inflation. Future spaceborne submillimeter and far-infrared missions will reveal information about the first stars and the early history of galaxy evolution. One challenge in making large focal plane arrays is how to couple the detectors to the instrument optics in a way that is scalable, easily fabricable, broadband, and robust during launch and in the space environment. Here we propose to develop planar lenslet arrays using metamaterials fabricated using silicon wafers. Instead of curved optical surfaces, the lenslets consist of a stack of silicon wafers each patterned with a periodic array of subwavelength features. We will develop two approaches based on our previous work: gradient-index (GRIN) lenslets produced by etching radially varying holes in the wafers, and metal-mesh lenslets produced by depositing a radially varying metal mesh grid that acts as a series of transmission line (TL) lumped element filters to control the wavefront phase delay across the lenslet. The advantage of these techniques is that they can be fabricated in only a few steps; they are precise, repeatable, scalable, mechanically robust, and the flat optical surface lends itself to a variety of broadband anti-reflection (AR) coating techniques, including impedance matching to free space using metamaterial itself.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Astrophysics Research and Analysis

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Organizations Performing Work	Role	Type	Location
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations	
California	Colorado

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

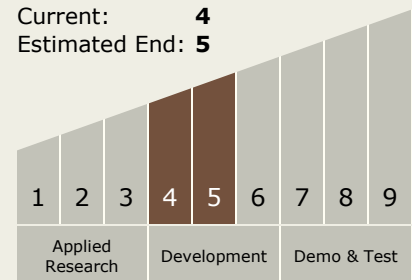
Nils W Halverson

Co-Investigators:

Adrian T Lee
 Giampaolo Pisano
 Jessica A Maass
 Johannes Hubmayr
 James A Beall
 Jason E Austermann

Technology Maturity (TRL)

Start: 4
 Current: 4
 Estimated End: 5



Technology Areas

Primary:

- TX08 Sensors and Instruments
 - TX08.1 Remote Sensing Instruments/Sensors

Continued on following page.

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Technology Areas (*cont.*)

- └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

Target Destination Outside the Solar System